What causes the Lyα forest, clouds or large-scale velocity fields ?

Wilhelm H. Kegel and Sergei A. Levshakov

[1] *Institut für Theoretische Physik der Universität Frankfurt am Main, Postfach 11 19 32, 60054 Frankfurt/Main 11, Germany*
[2] *Department of Theoretical Astrophysics, A. F. Ioffe Physico-Technical Institute, 194021 St.Petersburg, Russia*

If an additional *large scale* hydrodynamic velocity field is superposed on the general Hubble flow, the peculiar velocities have the effect that spatially separated volume elements along a given line of sight may contribute to the absorption at the same value of λ. This effect leads to a *'line-like'* absorption structure rather than to a smooth GP-depression. **From this it follows that at least part of the Lyα forest may be explained without invoking density fluctuations (clouds). Thus, there is no clear observational distinction between intergalactic clouds and the diffuse medium inbetween**.

We have investigated this effect by means of Monte Carlo simulations [1]. In Fig. 1 we present results based on a model in which we assumed the diffuse intergalactic medium to be (locally) homogeneous having at z = 3 the parameters $n(\mathrm{HI}) = 4 \times 10^{-11}$ cm^{-3} and $T_{\mathrm{kin}} = 10^4$K. For the large scale stochastic velocity field we assumed a rms velocity of $\sigma_t = 300$ km s^{-1}, and a correlation length $l = 6$ Mpc. In calculating the expansion rate we assumed $q_0 = 0.5$ and $\mathrm{H}_0 = 70$ km s^{-1} Mpc^{-1}. The value of $n(\mathrm{HI})$ was estimated from the continuum depression D_A at $z = 3$ observed in low resolution spectra, T_{kin} corresponds to the width of the narrowest lines in the Lyα forest, σ_t is half the value found for the peculiar velocities in the local universe [2], and the value of l corresponds to the expected size of voids at $z = 3$. We performed similar calculations for He II Lyα (Fig. 2).

Assuming a photoionizing rate of $\Gamma_{\mathrm{HI}} = 10^{-12}$ s^{-1} [3] one derives from $n(\mathrm{HI})$ a total baryon density of the order of 10^{-5} cm^{-3} at z = 3 corresponding to $\Omega_{0,\mathrm{IGM}} \simeq 0.03$, i.e. it is about 3 per cent of the mass needed to close the Universe. This result indicates that most of the baryonic matter is found in the IGM inbetween clouds.

Acknowledgements. This work was supported in part by the RFBR grant No. 96-02-16905-a and by the Deutsche Forschungsgemeinschaft.

References

[1] Levshakov S. A., Kegel W. H., 1997, MNRAS (submitted)
[2] Raychaudhury S., Saslaw W. C., 1996, ApJ, 461, 514
[3] Haardt F., Madau P., 1996, ApJ, 461, 20

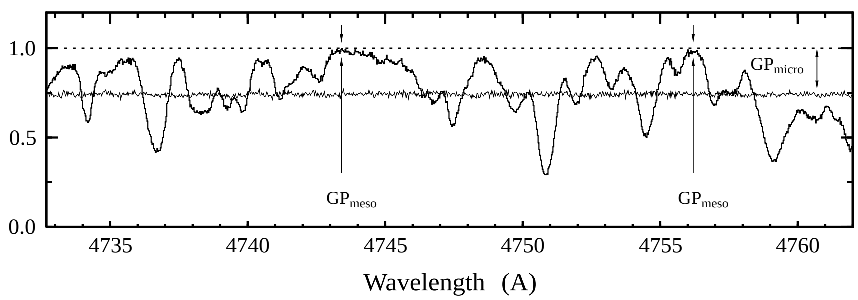

Figure 1: Monte Carlo simulation of the HI Lyα forest for a given velocity field realization at $z = 3$ (S/N = 100, FWHM = 8 km s^{-1}). The horizontal 'noisy' line shows a result for zero correlation coefficient, representing a classical GP-trough (marked by GP$_{micro}$). Commonly the diffuse intergalactic n(HI) is estimated by measuring the intensity distribution near the apparent continuum, these regions are labeled by GP$_{meso}$.

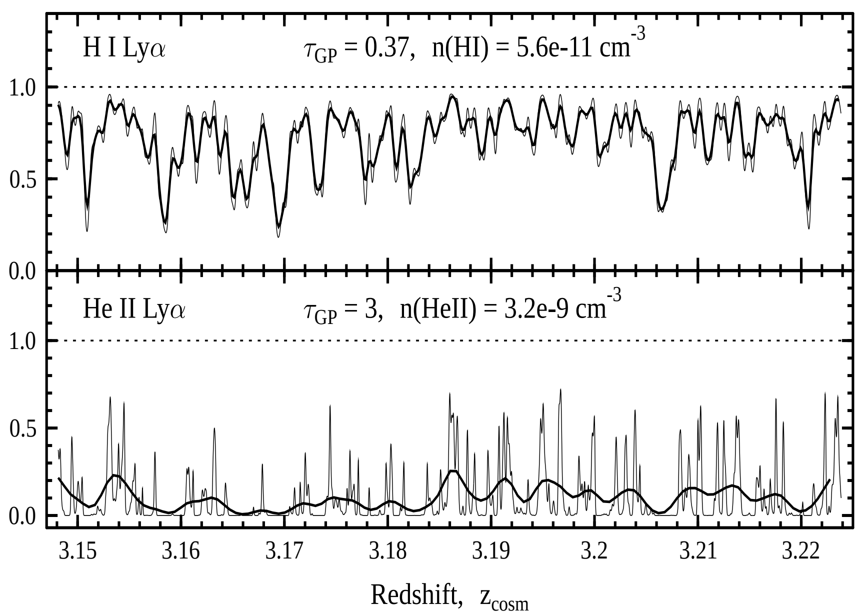

Figure 2: Monte Carlo simulation of the HI (upper panel) and the corresponding HeII (lower panel) Lyα forest at $z = 3.2$ (thin lines) calculated with S/N = 50. Also shown (thick lines) are the same spectra convolved with a spectrograph function of a 0.6 Å width.